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GeoTek Alaska, Inc.

September 24, 2012
12-1011

Mr. Jeff Fetters
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RE: Letter Report – Geophysical Survey at 4th Ave. & Gambell Street - Anchorage, Alaska

The following is a Letter Report submitted to Ecology & Enviroment, Inc (E&E) by GeoTek Alaska, Inc (GTA). This report concerns the performance of a Geophysical Survey for a project site at 4th Avenue & Gambell Street in Anchorage, AK. The Geophysical Survey was requested by Mr. Fetters (E&E).

Introduction

In support of an environmental site characterization, E&E contracted GTA to perform a geophysical survey at a project site location in Anchorage, AK (Figure 1). The project site is an undeveloped (gravel surfaced) parking lot located in the northeast quadrant of the intersection at 4th Avenue and Gambell Street in Anchorage, AK. The property was formerly used by a dry cleaner, C and K Cleaners, from 1968 to 1970, and an automotive service business, NC Tire Center from 1976 to 1978. High levels of chlorinated solvent and metal contamination have been detected in soils potentially associated with wood cribs and drums found on site. Currently, the project site is used for parking and a cellular communications tower (with associated equipment) located in the southeast corner. GTA was tasked with performing a geophysical survey to identify any data anomalies that may be attributed to possible buried objects (i.e., wood cribs, remaining building foundations, drums, UST's, wood cribs, piping, utilities, etc.).

Location

The project site is located in downtown Anchorage, AK. The property is in a primarily commercial business area with a few residential properties directly north of the site. The property is approximately 40,600 square feet and includes four (4) lots total. The property is on Block 26A of an addition to the town site of Anchorage (Figure 2).

Survey Area

The geophysical survey consisted acquiring both electromagnetic (EM) and ground penetrating radar (GPR) data over the entire parking area of the project site. The dimensions of the surveyed area were three hundred feet by one hundred forty feet (300 x 140 ft). The survey grid for the EM data was established in an east-west direction with a five foot (5 ft) separation between the line paths of data acquisition. The GPR survey grid was established using an orthogonal grid of line paths oriented in both an east-west and a north-south orientation. As with the EM61 data acquisition, the GPR data was also acquired using five foot (5 ft) line spacing. Both data acquisition grids (extent and data density) were reviewed, discussed, and agreed upon with the client prior to performing the survey.

Data Acquired

Data acquisition was performed during the dates of July 09, 2012 to July 11, 2012 (07/09/12 – 07/11/12). GTA collected a total of six thousand five hundred linear feet (6,500 ft) of EM data and fourteen thousand five hundred linear feet (14,500 ft) of GPR data. A total of 28 EM data lines and 88 GPR data lines were acquired during the geophysical survey. GTA also acquired GPS data for the positioning of the geophysical data. GTA collected Real Time Kinematic (RTK) GPS data that was interfaced with both the EM and GPR data by streaming a NMEA GGA data string to the geophysical equipment. As the base station for the RTK GPS data, GTA used a Continuously Operating Reference Station (CORS) located at the Anchorage International Airport (AIA).

Data Quality

The overall quality of the acquired EM data is good (on a scale of good, fair, poor). The quality of the GPR data is fair to a depth of approximately ten feet (10-ft).

Instrumentation and Technical Approach

The geophysical survey consisted of acquiring EM and GPR data over the entire project area using established grids. Following, is a brief description of the equipment used for the data acquisition of the geophysical data and the technical approach.

Electromagnetic (EM)

The EM equipment used for the data acquisition at the project site consisted of the Geonics EM61-MK2 metal detector. The following is a brief description of the equipment and basic concepts of operation:

Geonics EM61-MK2 - The Geonics EM61-MK2 is a high sensitivity, high-resolution, time-domain electromagnetic metal detector that detects both ferrous and non-ferrous metallic objects. The EM61 instrument is used for acquisition of electromagnetic data to identify anomalies associated with buried metal objects, including ferrous and non-ferrous metals.

The EM61 instrument consists of two coils mounted one above another on the coil assembly that serve as both transmitter and receiver. A steady voltage is applied to the lower or transmitter coil (peak power of 100 watts) that is sharply terminated at each cycle or pulse. A rapid reduction of the transmitter current, and thus of the associated primary magnetic field, induces an electromotive force in nearby conductors (i.e., metallic objects). This electromotive force causes electrical eddy currents to flow in conductors with decay characteristics that are a function of the conductivity, size, and shape of the conductor. The decaying currents generate a secondary magnetic field that is detected and measured by the two coils now acting as receivers. The measurements are made at a relatively long time (0.45 milliseconds) after

termination of the primary pulse. This delay in measurement provides for a response that is practically independent of the electrical conductivity of the ground due to the longer decay characteristic of electrical eddy currents in metallic objects than that of the ground. The measured response from the secondary magnetic field is proportional to the metal type, mass, shape, and depth of the conductor.

When using EM data it should also be understood that for a target to be detectable, several conditions must be met. Generally, three (3) conditions apply and they are; 1) the transmitted signal must induce currents inside the target. In the case of a resistive target, induced currents must flow around the target, 2) there must be a difference in electrical properties between the target and the surrounding material to generate an anomalous electromagnetic response, and 3) the anomalous electromagnetic response must be large compared to any noise signals or background response.

Ground Penetrating Radar

The GPR equipment used for the data acquisition at the project site consisted of the Sensors and Software pulseEKKO Pro system. The following is a brief description of the equipment and basic concepts of operation:

Sensors and Software pulseEKKO Pro system - The Sensors and Software pulseEKKO Pro system consists of a GPR antenna system (with attached transmitter and receiver) that is transported manually or by a lightweight cart. The GPR system also includes a Digital Video Logger (DVL), and battery. The DVL is where GPR data is recorded and displayed in wiggle trace format. The real-time display of traces allows the operator to see the acquired data on the DVL as the operator moves. This provides for quality control of data during acquisition, and the ability to observe diagnostic responses of buried objects (i.e., pipelines, boulders, void spaces, etc.).

GPR directs a pulse of radio waves (i.e., frequencies from 12.5 MHz to 1000 MHz) downward into the earth. Part of the transmitted energy of the waves is reflected back to the receiver from interfaces or objects with differing electrical

properties. GPR reflection data is recorded as a function of the two-way time required for a signal pulse to transmit, reflect, and return to the receiver antenna. The records of multiple, separate pulses at a single location (i.e., station) are summed to enhance the signal-to-noise ratio and produce a single trace for that station. The summed trace is transmitted in digital form to a data-logging instrument or computer. A GPR profile line consists of all of the data traces recorded along the profile line at a station spacing determined appropriate for the project objectives.

Differing soil properties produce reflection events in the GPR profile data. A reflection event is produced at an interface where the electrical properties (e.g., dielectric constant and electrical conductivity) vary with soil lithology, associated grain size and porosity, water saturation, and pore space chemistry.

Additionally, localized buried targets (both metallic and non-metallic) can also produce a reflection event that enables the location of the object, and determination of its depth in the subsurface. A hyperbolic shaped response or diffraction is diagnostic of localized buried targets. The top of the hyperbola in GPR profile data indicates the location of buried objects. The shape of the tails of the hyperbola provides for the calculation of the velocity of the radio waves in the subsurface. Thus, the depth of a buried object can be determined from the time of the reflection event for the object (top of hyperbola) and the calculated velocity of the radio waves in the subsurface.

Technical Approach

After identification of the area to be surveyed, data acquisition grids were established to provide complete data coverage over the area of interest at the project site. EM data was acquired in a grid fashion (east-west orientation) using appropriate grid line spacing for the objective of the geophysical survey. GPR data was acquired as profile lines along the same grid line paths of the EM grid and also in an orthogonal orientation of north-south. The geophysical survey grids were constructed using measuring tapes for line path location. Paint marks and small plastic cones were used to indicate the start and end of every grid line

so that data acquisition occurred along a straight line between the start and end of each line path in the grid. For both the EM and GPR data sets, a grid line separation of five feet (5 ft) was maintained. Data acquisition commenced when the survey grids were established and marked on the ground surface.

Due to vehicles in the parking lot, the EM data was initially acquired over approximately the eastern half (0.5) of the survey grid area. This area had been cleared of vehicles prior to data acquisition with the exception of a large piece of heavy equipment (i.e., front end loader) located north of the cellular communication tower. The following day, the remainder of the EM data acquisition was performed over the western half (0.5) of the survey grid area during the evening hours after all of the parked vehicles had left the parking lot.

The GPR data was acquired over the entire parking lot in a single acquisition period. The data acquisition was performed during the late evening (1800 hrs to 2000 hrs) after all of the parked vehicles had left for the day. No vehicles (including the front end loader) were present in the survey area during the acquisition of the GPR data.

Once acquisition was completed the two (2) data sets were transported to GTA's office for download from the geophysical equipment. The raw data was reviewed for quality assurance, and final processing of the EM and GPR data was accomplished.

GPR Data Processing

The geophysical data were processed using state-of-the-art geophysical processing software. The EM data was processed using Geosoft's Oasis montaj (v7.5.01) software and the GPR data was processed using Sensors and Software's Ekko Mapper (v4). In general the data processing focused on achieving the best quality for interpretation purposes, but applied conservatively to avoid any introduction of processing artifacts or misrepresentation of anomalies in the data sets. The goal of the processing is to produce plan views

of the data for the identification of any anomalies associated with possible buried objects.

Control Surveying

The dimensions of the geophysical survey grid were chosen to include as much of the project area as possible. The positioning of the geophysical data was accomplished by using a Leica 1200 GPS unit and Real Time Kinematic (RTK) positioning. The Anchorage International Airport (AIA) Continuously Operated Reference Station (CORS) was selected as the base station for the RTK positioning. All positioning data acquired in the field used the WGS84 datum and geographic coordinate system (latitude and longitude). The positioning of the geophysical data was transformed post survey to the Alaska State Plane Zone 4 (ASP Z4) coordinate system using the NAD83 Datum. The coordinate transformation was performed using Geosoft Oasis montaj v7.5.1 software. All geophysical data positioning and maps shown in this report are displayed using the ASP Z4 coordinate system with a NAD83 Datum.

Results

The results from the geophysical survey at the project site on 4th & Gambell in Anchorage, AK are shown in Figures 3 - 9. The figures included in this report are listed below:

Report Figures

Figure 3 – Location Figure of EM Data Survey Grid

Figure 4 – Location Figure of GPR Data Survey Grid

Figure 5 – EM Data Acquisition Line Path from GPS Positioning

Figure 6 – Color Contour Map of the EM Data

Figure 7 – Color Contour Map of the GPR Data (Depth Slices 3.28-ft to 3.69-ft and 4.10-ft to 4.51-ft)

Figure 8 – Color Contour Map of the GPR Data (Depth Slices 4.51-ft to 4.92-ft and 4.92 to 5.33)

Figure 9 – Color Contour Map of the GPR Data (Depth Slices 6.15-ft to 6.56-ft and 9.43 to 9.84)

Prior to a discussion of the results for the EM data acquired at the project sites, it is important to understand how the color display/contour maps of the geophysical data were produced. A brief description of the presentation methods for the color displays in Figures 6 - 9 follows:

EM Data Display

The mapping and identification of any EM data anomalies at a project site are accomplished by producing color contour maps of the acquired data. The geophysical and location data acquired at a project site consists of a measurement made by the geophysical instrument at a specific location (x,y). The unit of measurement for the EM61 instrument is millivolts (mV). Depending on the depth of burial, metal (surface or subsurface) will normally produce anomalously high data values from the surrounding background instrument readings within an appropriately designed survey grid. The instrument readings are mapped by processing the data in conjunction with the location data to produce color contour maps of the geophysical data. Anomalously high data values or peak values are then identified by choosing the appropriate colors and contour intervals to enhance the differentiation of the peak or anomalous data values from the background data values for each project site. For the color contour figures included in this report, a color scheme has been selected that assigns hot colors (magenta, pink, red, etc.) to the higher data values, cooler colors (orange, yellow, greens, etc.) for the mid range data values, and blues and gray for the low or background values.

GPR Data Display

Traditionally, GPR data is presented as two-dimensional (2D) cross sections of the subsurface. In GPR surveys where numerous lines of data have been acquired, interpretation of many 2D cross sections can become confusing. The interpretation of GPR data can be enhanced, depending on the objective of the survey, through the use of plan map displays of the data. The ability to see GPR responses in map view allows the interpreter to see the spatial correlation of targets. This can make the interpretation easier as targets of

interest can be differentiated from other GPR responses of no interest. For example, responses from utilities tend to produce linear anomalies while responses from other local objects like rocks will appear as point anomalies. Thus, using the plan map display can enhance the interpretation of GPR data over the traditional 2D cross section.

Figure 5 presents the line paths of the EM data based on the acquired GPS positioning data. This figure indicates the gaps in the data set due to parked vehicles, front end loader, and other obstructions (e.g., utility poles). The individual line paths are numbered at the ends of the line path segments. Figure 5 is shown to indicate the EM data coverage so that it can be referenced when viewing the color contour map of the EM data.

Figure 6 presents a color contour map of the EM response from the bottom coil of the EM61 instrument. In Figure 6, higher amplitude anomalies are readily observable by the hotter colors (i.e., magenta, pink, and red) in the color contour map. The anomalies have been outlined in Figure 6 by black ovals or circles. While other anomalies are observable in the color contour map, they are not outlined because of their association with surface metal (e.g., sign posts, utility poles, fences, parked vehicles, and heavy equipment). Only the anomalies that could not be attributed to surface metal have been outlined and identified in Figure 6.

Figures 7 - 9 present color contour maps of selected depth slices from the GPR data set. These particular depth slices were selected because they include GPR data anomalies that coincide with locations of EM data anomalies. The GPR data serves as a corroboration of the EM data anomalies and provides for a depth determination of the source of those anomalies. The depths of the horizontal slices through the GPR data set are identified to the right of the color contour map for each of the selected depth slice. Anomalies identified in the GPR data set have been outlined with black or yellow rectangles in Figures 7 - 9.

Additionally, the GPR profile lines indicate disturbed soil in the areas of the data anomalies. This may be either an indication of burial, or the removal of buried objects.

Conclusions

In conclusion, GTA accomplished the objectives for this geophysical survey at the project site near the intersection of 4th Avenue and Gambell in Anchorage, Alaska. The following are some general comments from the interpretation of the geophysical data:

- Six thousand five hundred linear feet (6,500 ft) of EM data and fourteen thousand five hundred linear feet (14,500 ft) of GPR data were acquired at the project site. The quality of the EM data is good (on a good, fair, poor basis) and the quality of the GPR data is fair to a depth of approximately ten feet (10-ft). The geophysical data sets provide for the objective of the geophysical survey to be met.
- Based on color contour maps of both the EM and GPR data sets, several anomalies were identified within the project site boundaries. In general, the eastern half (0.5) of the project site contains most of the anomalies that have been identified in the geophysical data. Additionally, most of the EM data anomalies have been corroborated by the GPR data due to the coincidence of the locations of the anomalies in both data sets. All of the anomalies identified exist within the depth range of three feet to ten feet (3-ft to 10-ft).

  It should be noted that some of the anomalies observed in the data sets are associated with known utilities (i.e., gas pipeline, buried electrical lines, etc.) in the project area. These anomalies are located along the eastern and northern boundaries of the project site.

  Additionally, two (2) anomalous areas in the EM data did not produce any appreciable extent of anomalous data in the GPR data. In particular, a relatively large anomaly observed in the EM data and located in the north central area of the survey grid does not produce an anomaly in the GPR data

with the same areal extent. There also appears to be a linear EM data anomaly in the eastern portion of the survey area that is oriented north-south and extends from the northern project site boundary to just north of the cellular communication tower. The GPR data did not produce a readily observable anomaly along the same location with the exception of a much smaller GPR anomaly at the southern end of the linear anomaly observed in the EM data. It is uncertain why there exists the difference in the anomaly identification between these two (2) data sets, but it is a good example of why it is important to acquire corroborating data sets.

- The GPR profile line data also indicated considerable soil disturbance in conjunction with the EM and GPR data anomalies. This soil disturbance is interpreted to be an indication of excavation activities for either burial or removal of objects into or from the subsurface. While most of the disturbed soil was observed in the eastern portion of the survey grid, there are a few smaller areas in the western portion of the survey grid (associated with the identified anomalies) where disturbed soil is also present.

Limitations of Technical Services

GeoTek Alaska, Inc. (GTA) performed our services in a manner consistent with the skill level of currently practicing professionals under similar conditions. GTA's investigations are conducted within the design limitations of the equipment used for the purposes described in this report. Interpretations developed and presented in this report are based on the data collected by GTA in the field and were performed to the best of the interpreter's abilities. Limitations exist as actual site conditions may vary; thus no warranty is expressed or implied. This report is intended for the exclusive use of Ecology and Environment, Inc. and their authorized parties for purposes described herein.

Closure

GeoTek Alaska, Inc. appreciates this opportunity to support Ecology and Environment, Inc. with a geophysical survey in Anchorage, Alaska. GTA remains available to assist E & E with future projects. Should you have any questions or require any additional information, please do not hesitate to contact the undersigned at (907) 569-5900.

Sincerely,

Chris Nettels
President/Consulting Geophysicist

GeoTek Alaska, Inc.
Geophysical and Environmental Site Assessment

Ecology & Enviroment, Inc.

4th & Gambell - Anchorage, Alaska

Project Location Map

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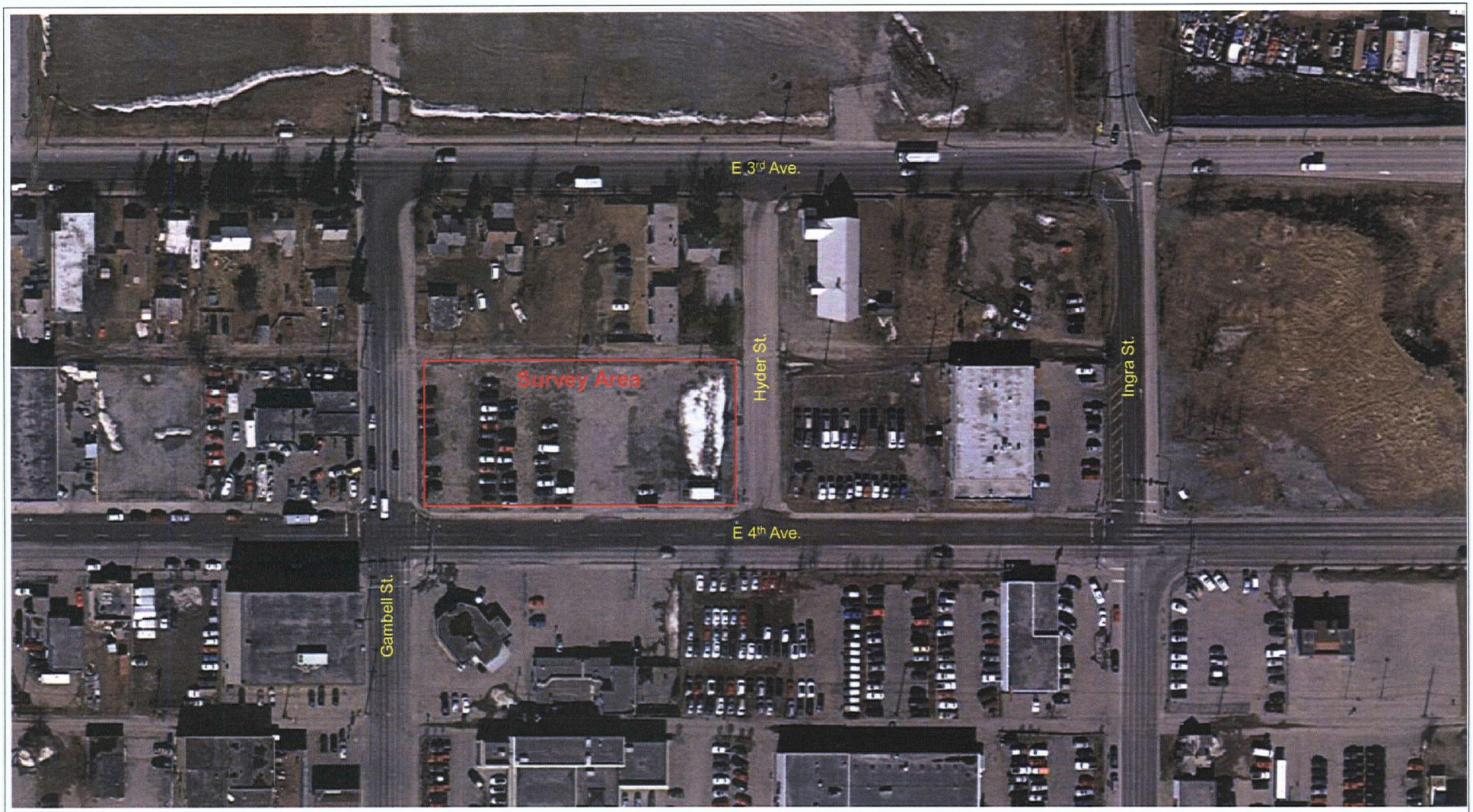

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Project Location Map

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EM61 Data Survey Grid

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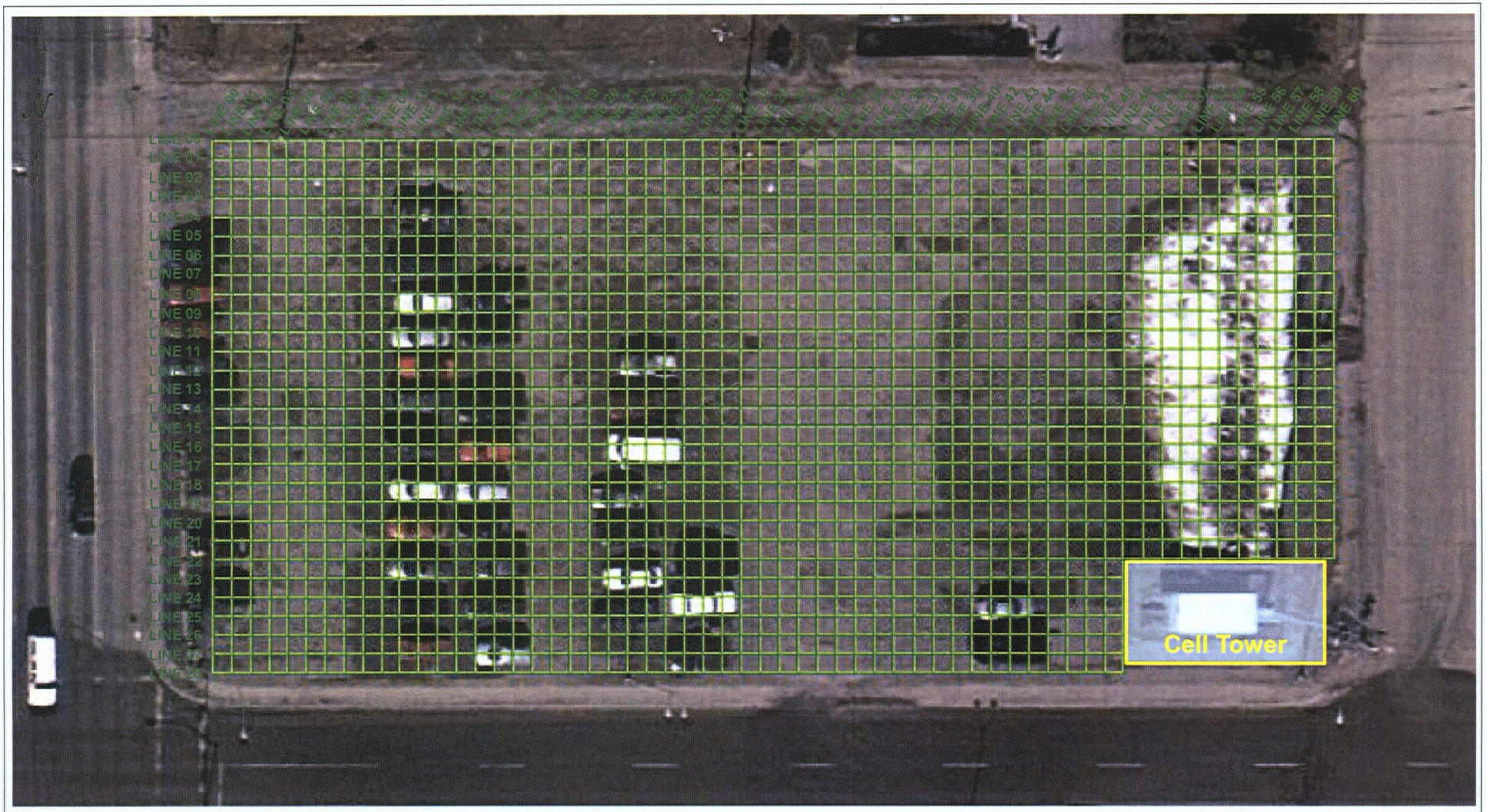

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GPR Data Survey Grid

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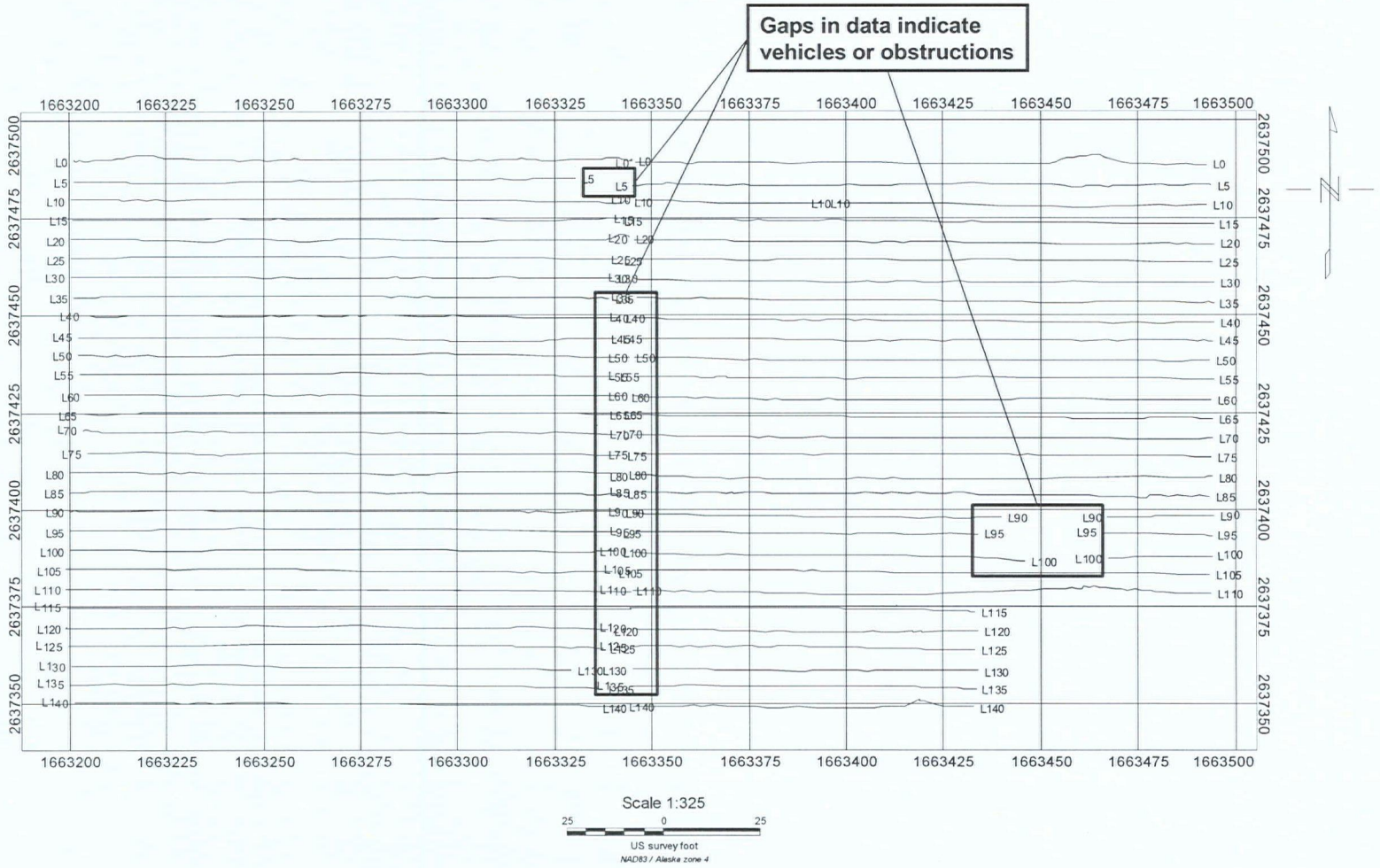

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EM Data Line Path

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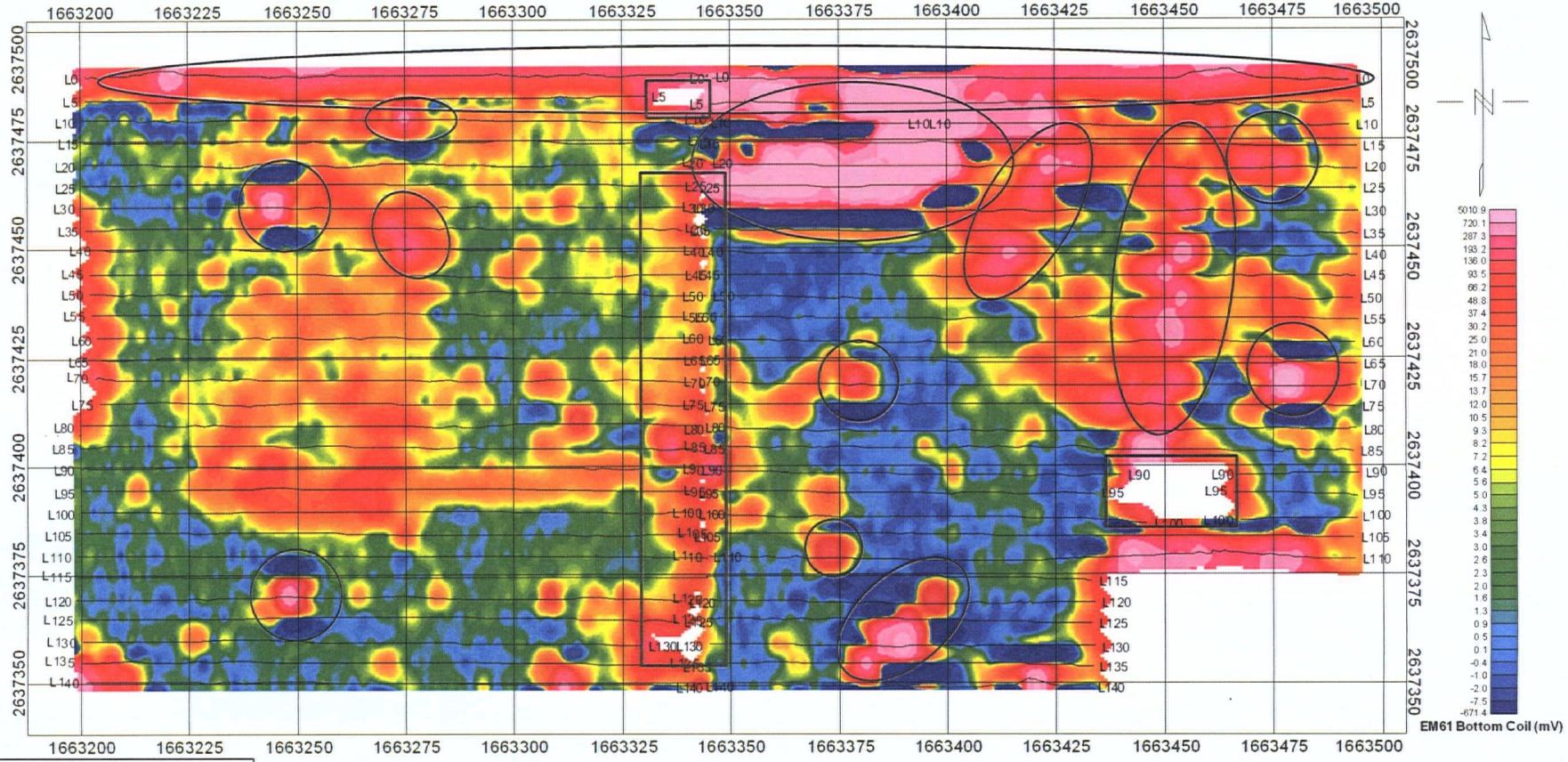

Legend

- EM Data Anomaly
- Obstructions

Scale 1:325

25 0 25

US survey foot

NAD83 / Alaska zone 4

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Color Contour Map – EM61 Bottom Coil Response

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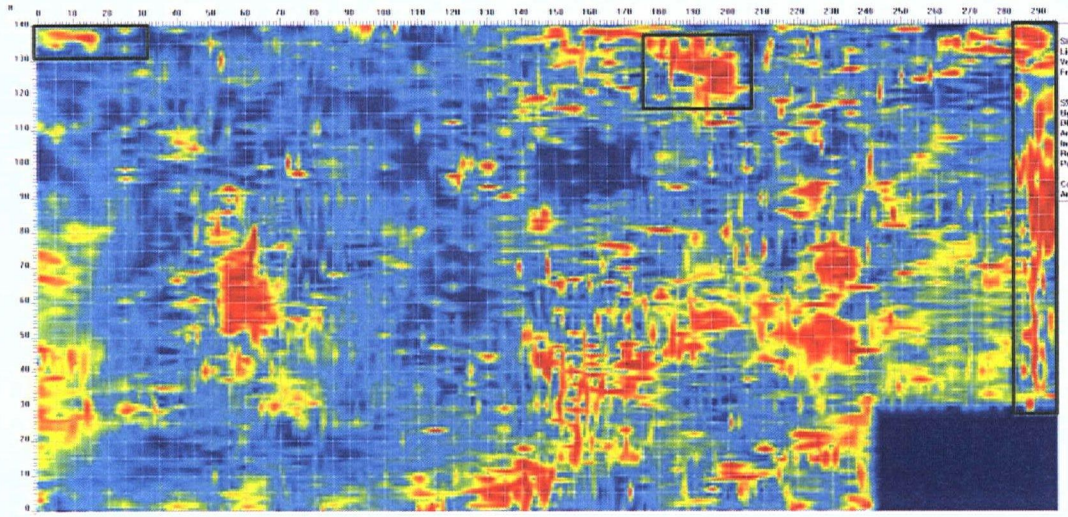
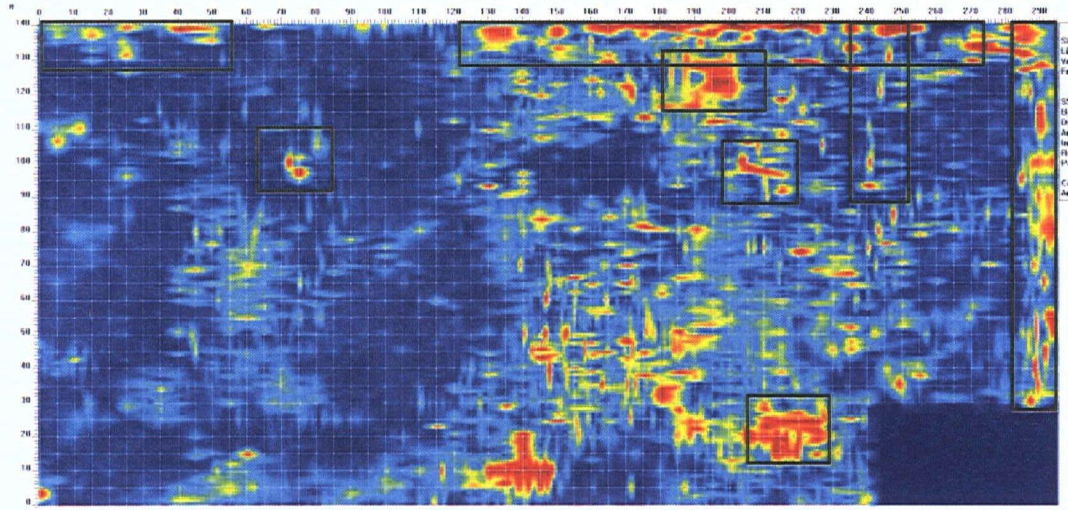


3.28 – 3.69 ft. (bgs)



4.10 – 4.51 ft. (bgs)

0 50ft.

Legend

☐ Anomaly

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Color Contour Map of GPR Data

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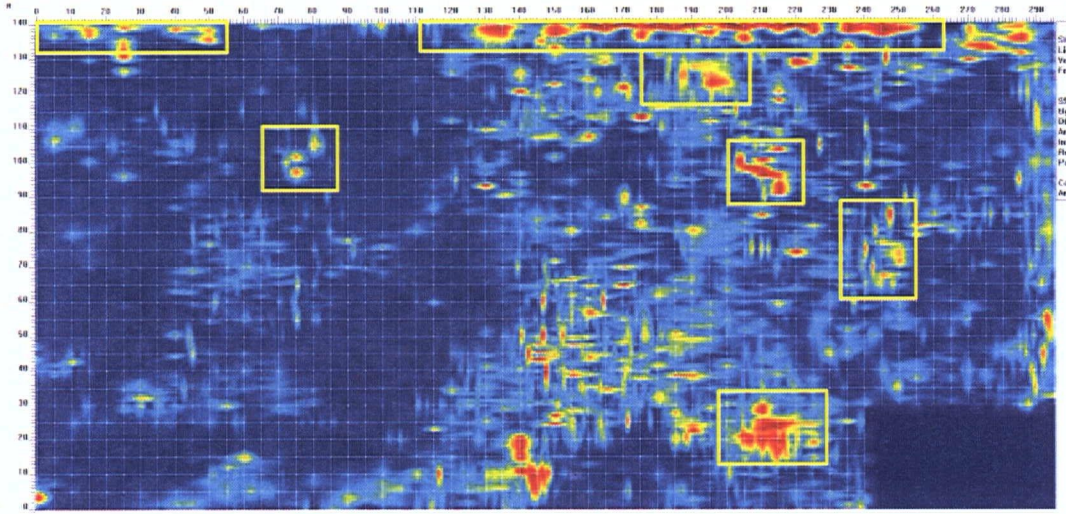
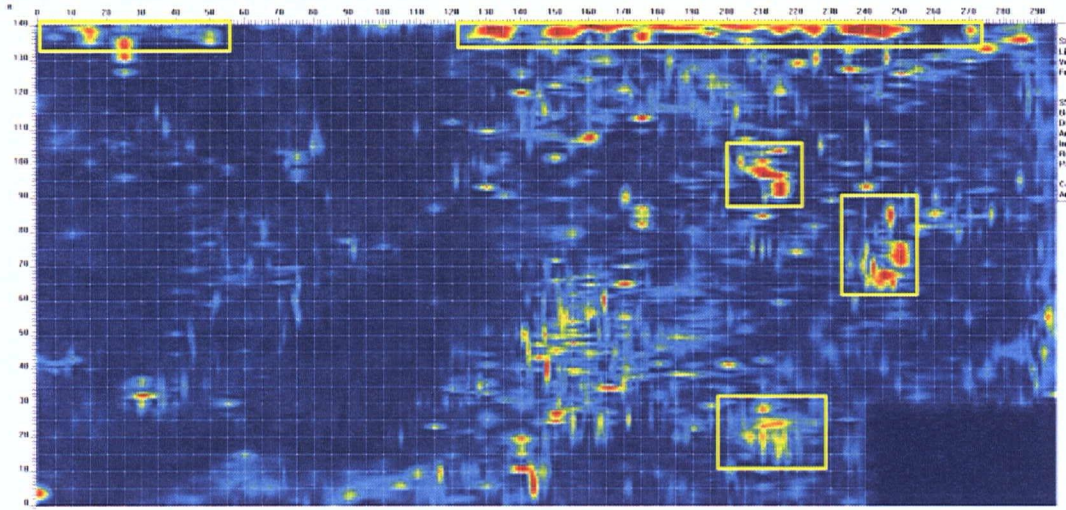


4.51 – 4.92 ft. (bgs)



4.92 – 5.33 ft. (bgs)

0 50ft.

Legend

Anomaly

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Color Contour Map of GPR Data

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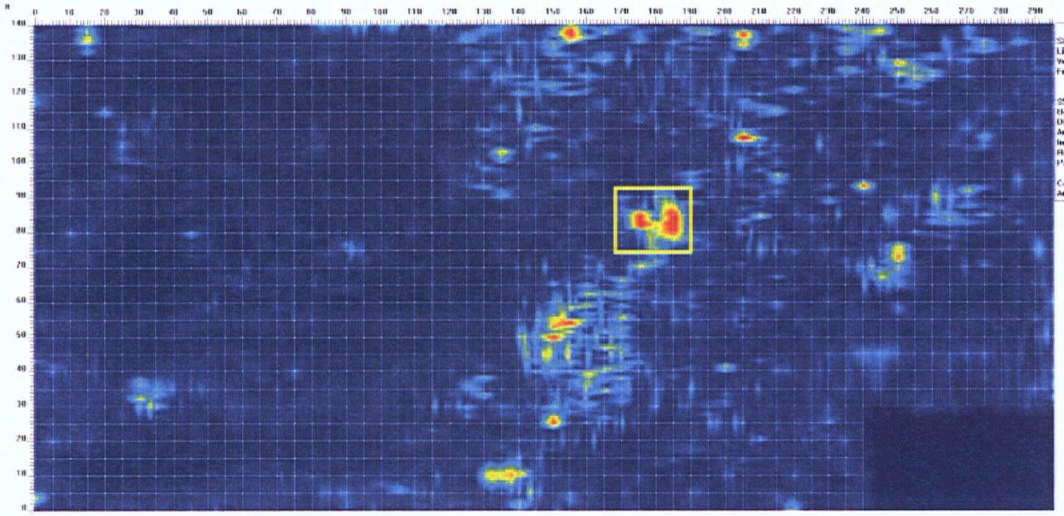
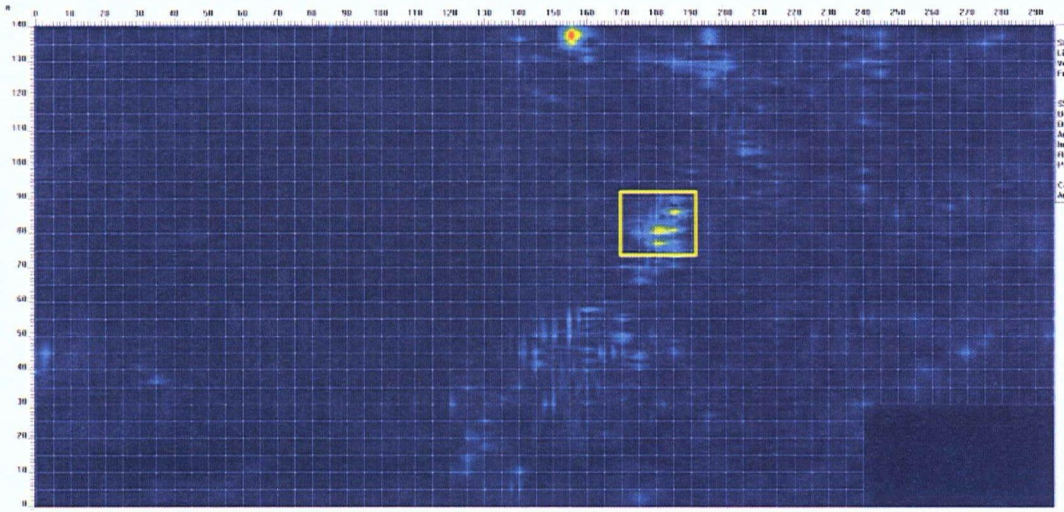


6.15 – 6.56 ft. (bgs)



9.43 – 9.84 ft. (bgs)

0 50ft.

Legend

Anomaly

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Color Contour Map of GPR Data

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